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STRUCTURAL ANALYSIS
OF THE LAMARS ASSEMBLY

NOVEMBER 1981

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AEROSPACE STRUCTURES
INFORMATION AND ANALYSIS CENTER

OPERATED FOR THE AIRFORCE FLIGHT DYNAMICS LABORATORY
BY ANAMET LABORATORIES, INC.

Report No. 1181.1A

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Aerospace Structures
Information and Analysis Center

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This report describes the transient response analysis of the primary structure of the Large Amplitude Multimode Aerospace Research Simulator (LAMARS). Critical parts of the structure were identified and examined under combinations of applied loads. Transient loads consisted of the accelerations created by the actuator in simulating roll, pitch and yaw, in addition to lateral and vertical motions of the cockpit simulator. These transient loads were superimposed on the static 1-g load on the structure to obtain the total stresses in the structure. Safety factors were established for all suspected critical structural locations.

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I. INTRODUCTION

This report presents the results of a transient response analysis of the LAMARS primary structure using NASTRAN, level 17.0 (rigid format 9). LAMARS (Large Amplitude Multimode Aerospace Research Simulator) is a five degree-of-freedom motion system composed of a single-place aircraft type cockpit and a display screen at the end of a 30 foot beam. The simulator is used for engineering simulation in order to evaluate flying qualities, flight control system designs and vehicle performance. Figure 1 illustrates the size and configuration of the LAMARS system.

The LAMARS structures can be divided into three major substructures. The base (or pedestal) is essentially an A-frame structure made up of massive I-beams and channels. The beam is a tapered cylindrical shell. The cockpit assembly contains a standard aircraft type cockpit and seat, along with supporting structure for a spherical screen and various projectors and power supplies. Three gimbals and a roll ring connect these three main subassemblies to each other. Five degrees-of-freedom are obtained by this structural design. These include roll, pitch and yaw of the cockpit about the beam end and two degrees-of-freedom referred to as beam vertical and beam lateral. These last two are obtained as the beam end moves vertically or laterally due to corresponding pivoting motions at the beam-pedestal gimbal connection. Five sets of actuators driven by a computerized control system produce precise phase and amplitude motion at the pilot's station to simulate aircraft ride. The control specifications cite maximum driving frequencies of 1.4 Hz for pitch, 1.8 Hz for roll, 2.9 Hz for yaw and 1.8 Hz for beam vertical and lateral. Initial estimates and a simplified analysis of the LAMARS systems indicated that the lowest natural frequency of the system would be near 4.0 Hz. Based on this judgment, it appeared to be necessary to perform a transient response analysis since the dynamic response of the system could

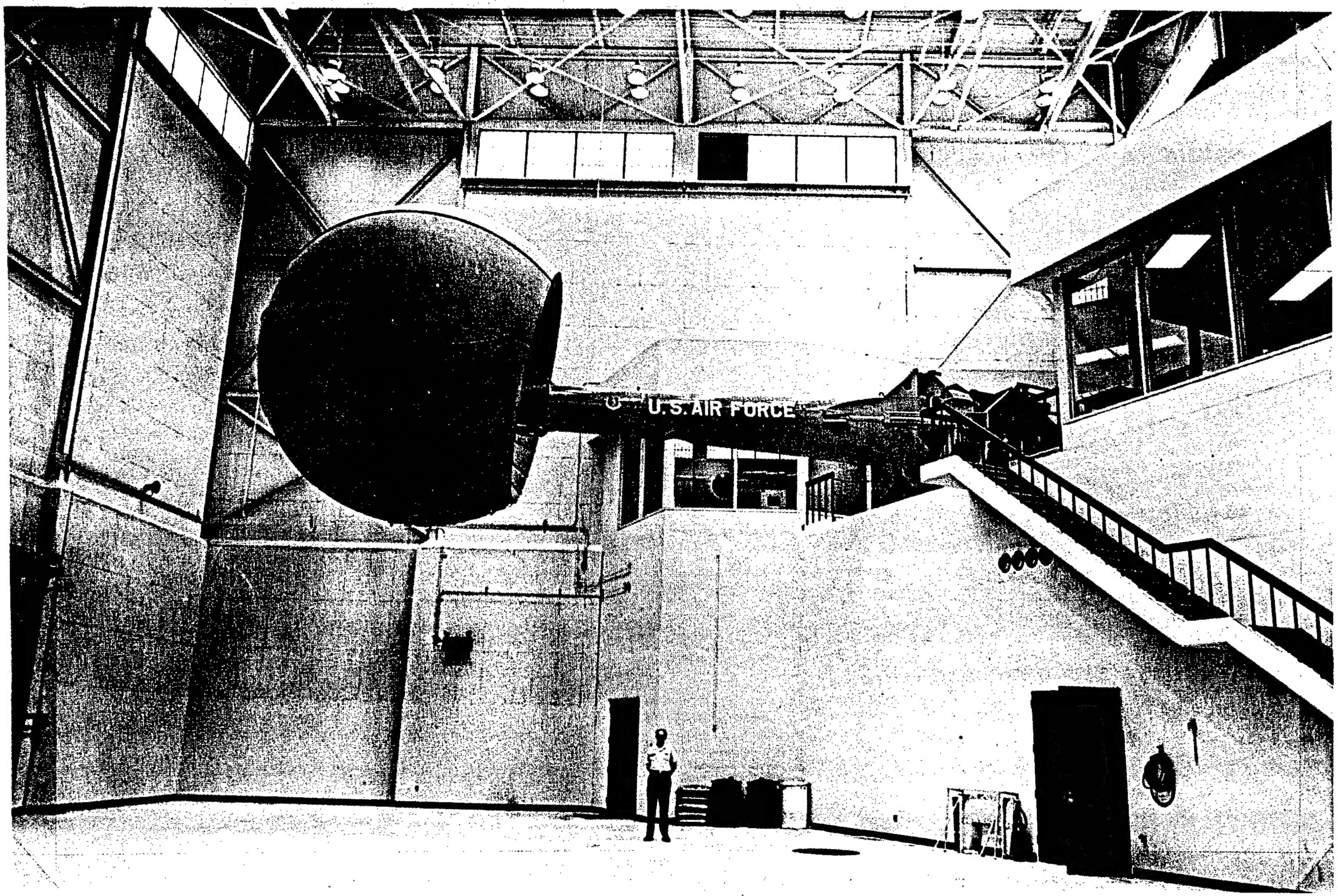

Figure 1 View of the LAMARS Installation

affect the maximum stresses in critical areas. During the actual analysis, the lowest natural frequency was found to be approximately 2.6 Hz, which is in the range of the actual driving frequencies. The transient response capability of NASTRAN was chosen because it provides a direct simulation of the dynamic structural response of the system due to initial conditions and time-varying loads.